Space Weather Technical Forecast

Issued on Tuesday, 30 January 2024 at 13:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further R1/R2 Radio Blackouts. Possible glance from CME and Chance of G1 day 2 (31 Jan). Chance of S1 Radiation Storms reoccurring should and significant flares occur.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is now Low, with a peak flare of C6.0 from off-going AR3559 peaking at 29/1456 UTC. There are currently six sunspot regions on the disc, including four unnumbered regions. Limb foreshortening is now preventing further analysis of AR3559 on the northwestern horizon, as such its previous parameters are conserved. The leading spot of AR3565 in the east has now split. This was previously a single penumbra with two bipolar regions within giving the classification of a delta. This spot has now been reclassified to a simpler beta, though still comprised a north-south alignment. The as yet unnumbered region rounding the northeast limb appears moderately active and the current foreshortened view makes accurate analysis difficult, though in recent hours, this spot appears to be developing, now with a large asymmetrical trailing spot. All other spots are small and simple.

No Earth-directed CMEs were evident in coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR and ACE at L1 showed a likely transition from the fast wind of CH95/- into the fast wind of CH94/-. The solar wind was at slightly elevated levels, between around 400-500 km/s. The solar wind density trace was less clear, but generally around or slightly above average. The IMF was weak throughout, around 4-8nT, on a general decline. The north-south component varying between +6 and -7nT, with an erratic character which also weakened with time. The Phi angle was predominantly negative (towards the Sun). The net result of the above solar wind measures was Quiet (Kp 0-2) geomagnetic activity.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was above S1 radiation levels until 30/0425 UTC, and briefly above S2 radiation levels between 29-1740-1900 UTC. This was in response to the M6.8 flare. 10MeV proton flux has been on a gradual decline ever since but remained elevated compared to background levels.

GOES16 high energy (greater than 2MeV) electron flux was at Normal Background to Moderate. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a generally steady trend. At 30/0000 UTC the 24-hour integrated fluence observation was 1.22e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Chance of further M-class flares and a Slight Chance of isolated X-class flares in the near term. This risk reducing somewhat into the period as AR3559 fully departs the visible disk around midweek UTC.

Solar Wind / Geomagnetic Activity: Generally Quiet to Unsettled conditions expected in association with coronal hole influence initially, with a chance of Active intervals. The peak risk of geomagnetic activity into day 2 (31 Jan) associated with the expected shock arrival from the

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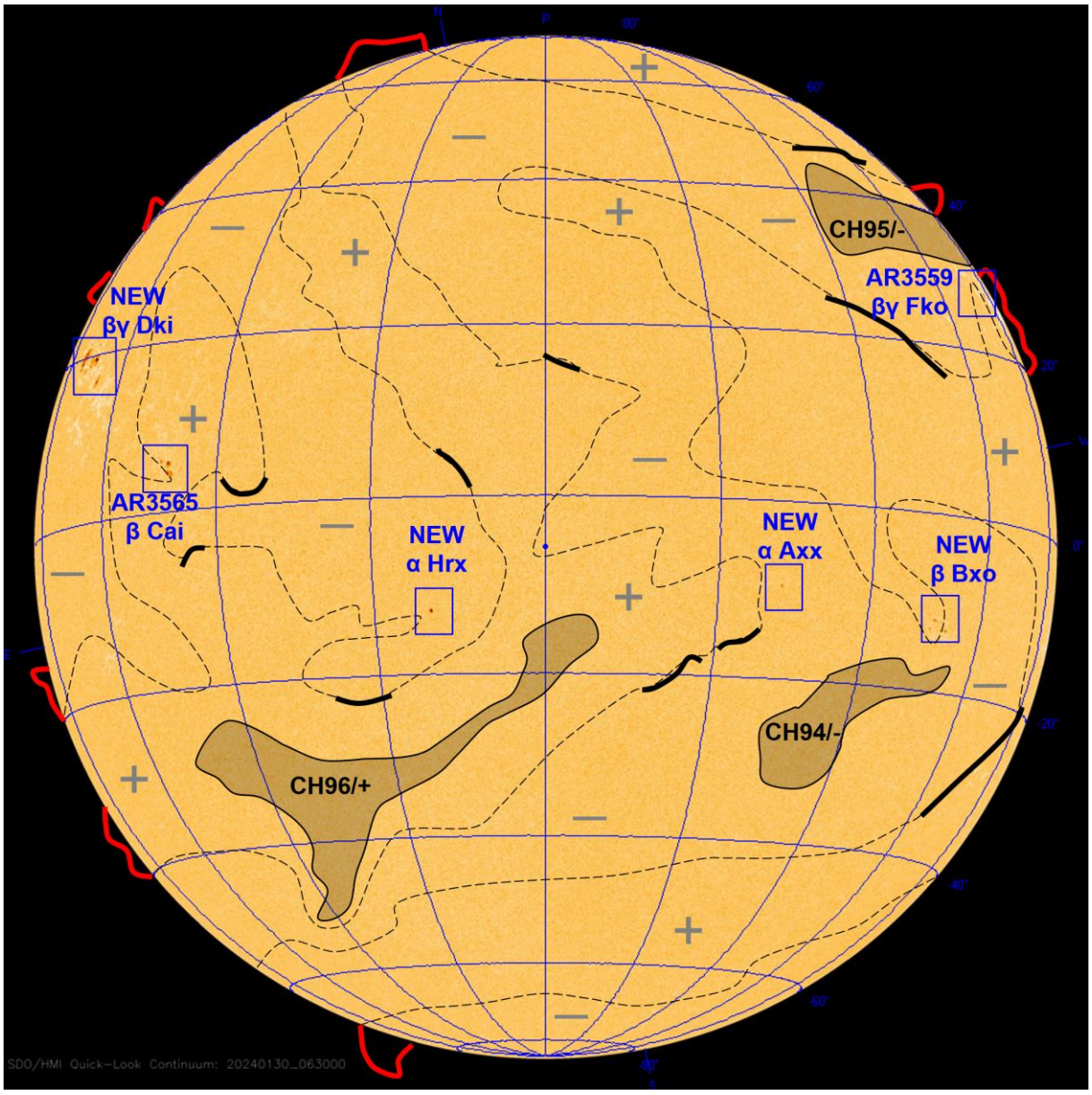
29/0438UTC CME, with Active intervals likely and a chance of G1 Minor Geomagnetic Storms.

Energetic Particles / Solar Radiation: High energy proton flux is Expected to remain below the S1 Radiation Storm level, with only a Chance of going above, should any significant flares occur on day 1 (30 Jan). This risk reduces through the period back in line with raw probabilities.

The high energy electron flux (greater than 2MeV) is relatively low confidence due to current coronal hole influence, however exceedance of Active is deemed unlikely throughout.

Figure 1. Solar Analysis Valid 30/0630 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME that currently features in the forecast - that from the M6.8 from AR3559 at 29/0438UTC. MOSWOC Enlil modelling of this feature suggests the main bulk of the ejecta will pass well west of the Sun-Earth line early in the UTC day of Wednesday 31 January. Having said this, the shock clearly shows a partial halo component. As things stand, the CME crosses 1AU ahead of Earth early on day 2 (31 Jan), with some ensemble members seeing a faint Earth glance from the flank later in the day. There is a Chance of G1 Minor Storm periods, probably contained within the UTC day of 31 January.

Current solar wind conditions are indicative of a minor coronal hole fast wind enhancement, with the source likely CH94. Its influence expected to persist through day 1 (30 Jan), with an overall falt or slight downward trend in wind speeds.

The next coronal hole enhancement is from CH96/+ in the southern hemisphere. This coronal hole has two parts, a leading portion and a trailing portion which are tenuously linked via a narrow and faint section. The arrival of the leading portion may be day 4 (02 Feb) or perhaps after this period (03 Feb). Solar wind speeds may once again reach 450-500 km/s, with an associated slight chance of any geomagnetic enhancement.

All considered, generally Quiet to Unsettled condition expected with a chance of Active intervals initially, the peak risk of geomagnetic activity is expected into day 2 (31 Jan) associated with the expected shock arrival from the 29/0438UTC CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	40	5	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/0753	Partial	AR3559	NW Limb	1150 km/s	31/0600-1800	Shock expected with bulk of ejecta expected to miss.

Figure 2: MOSWOC ENLIL and ENLIL Ensemble showing CME arrival possibilities.

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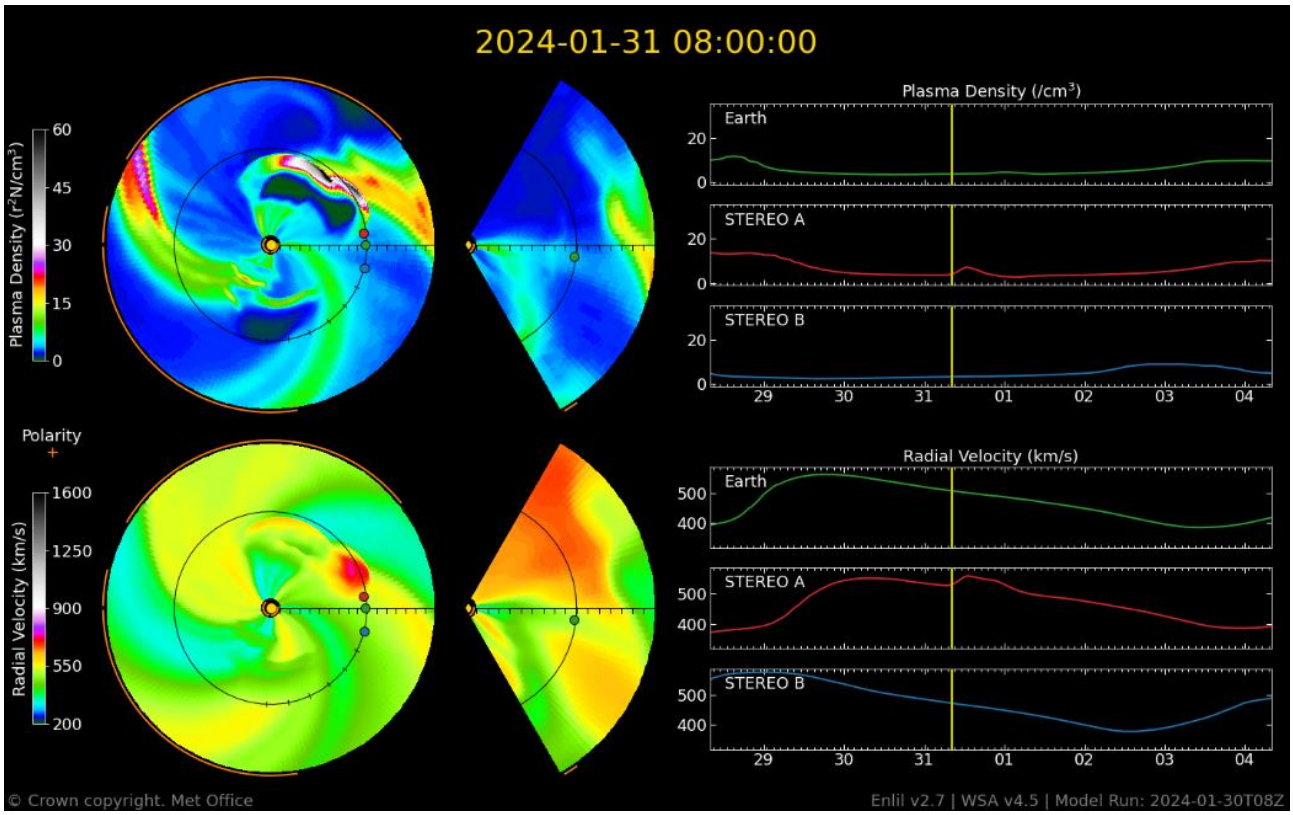

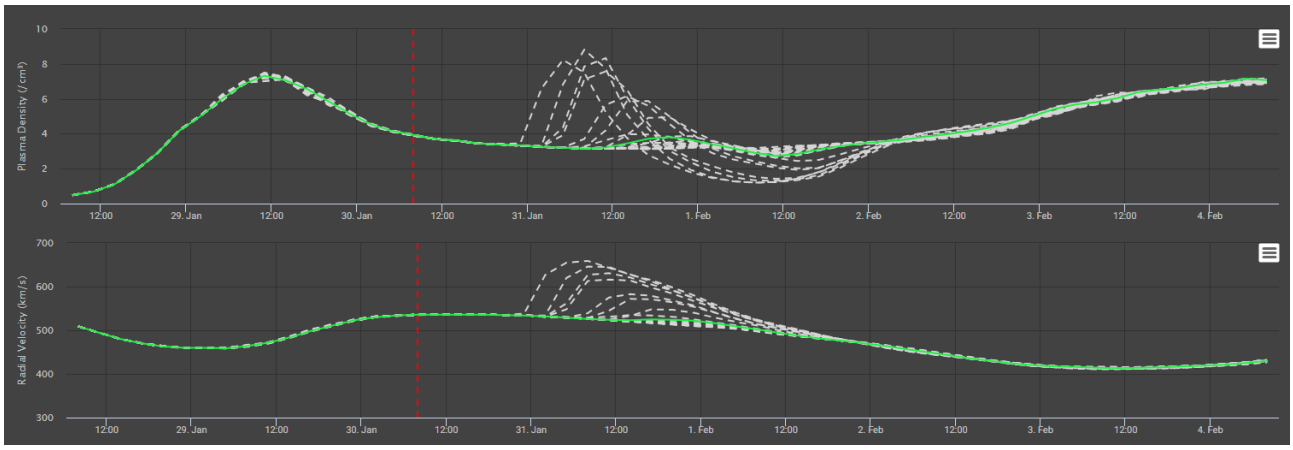

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Radio Blackouts - X-Ray Flares:

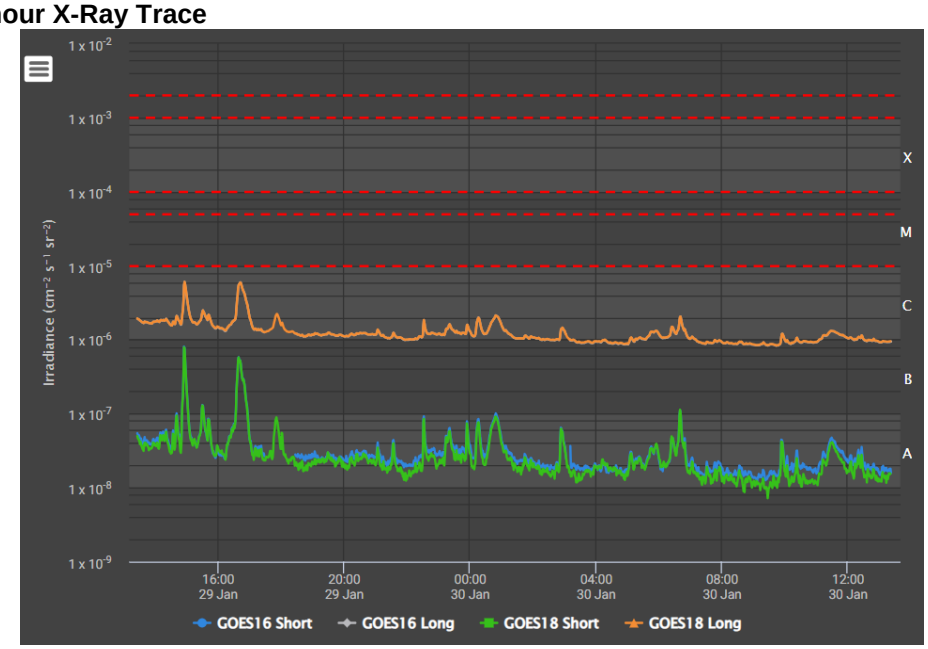
Low activity is expected with a chance of rising to Moderate, should any M class flare occur. These most probably from the off-going AR3559 or the oncoming unnumbered region in the northeast.

There are currently six sunspot regions on the disc, including four unnumbered regions. Limb foreshortening is now preventing further analysis of AR3559 on the northwestern horizon, as such its previous parameters are conserved. The leading spot of AR3565 in the east has now split. This was previously a single penumbra with two bipolar regions within giving the classification of a delta. This spot has now been reclassified to a simpler beta, though still comprised a north-south alignment. The as yet unnumbered region rounding the northeast limb appears moderately active and the current foreshortened view makes accurate analysis difficult, though in recent hours, this spot appears to be developing, now with a large asymmetrical trailing spot. All other spots are small and simple.

The balance of active regions on the facing side is expected to be fairly constant in number but probably not potency, with the departure of AR3559 expected fully into day 2 (31 Jan), and with AR3559's flare looking currently unlikely to be matched by any east limb arrivals, a general decrease in flare risk is likely.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-Ray Trace



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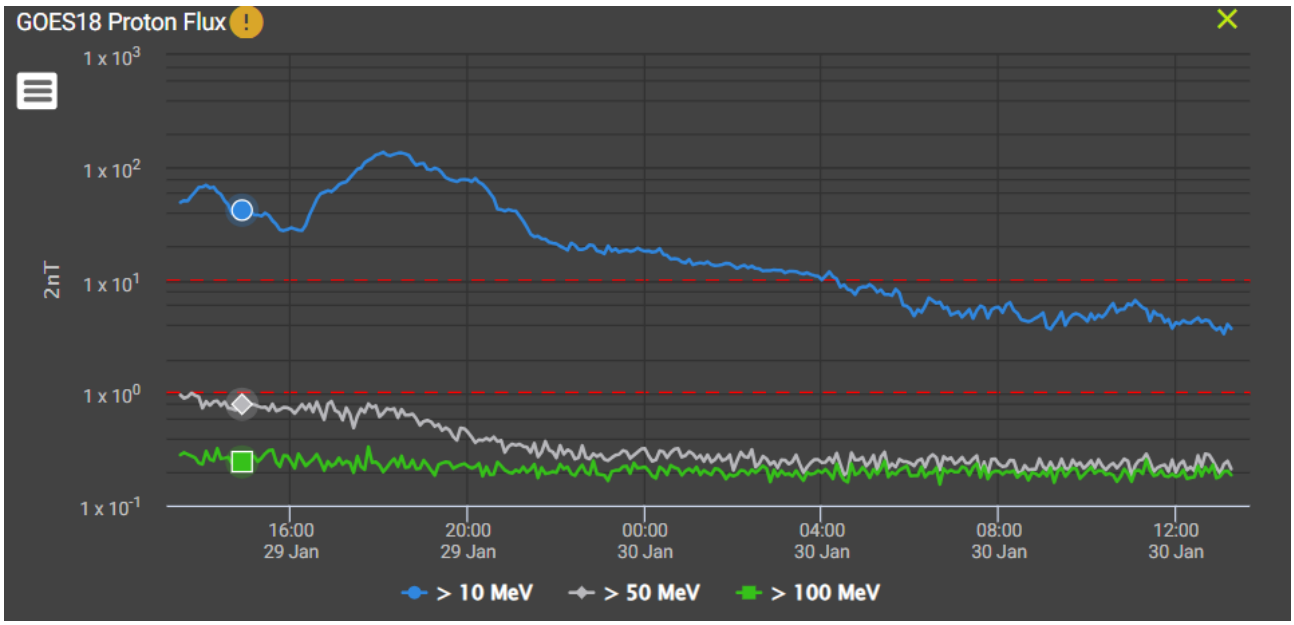
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux showed a hard spectral response to the 29/0438UTC M6.8 flare from AR3559, with very little transit delay to L1 and Earth. All measured energies showed an uptick and initial plateau, followed by a further increase in flux to S2 levels before beginning a gradual declining trend below S2 and now S1 by 30/0430UTC.

The evolution from here depends on how many further suitable flares might be produced, with it unclear as to whether AR3559 remains significantly unstable presenting a risk of further proton-producing flares given it's location on or around the northwest limb. The risk of breaching the S1 threshold is now only a Chance, should any significant flares occur. This risk reduces through the period back in line with raw probabilities, as the expected proton flux falls back to background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	25	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour High Energy Proton Trace.



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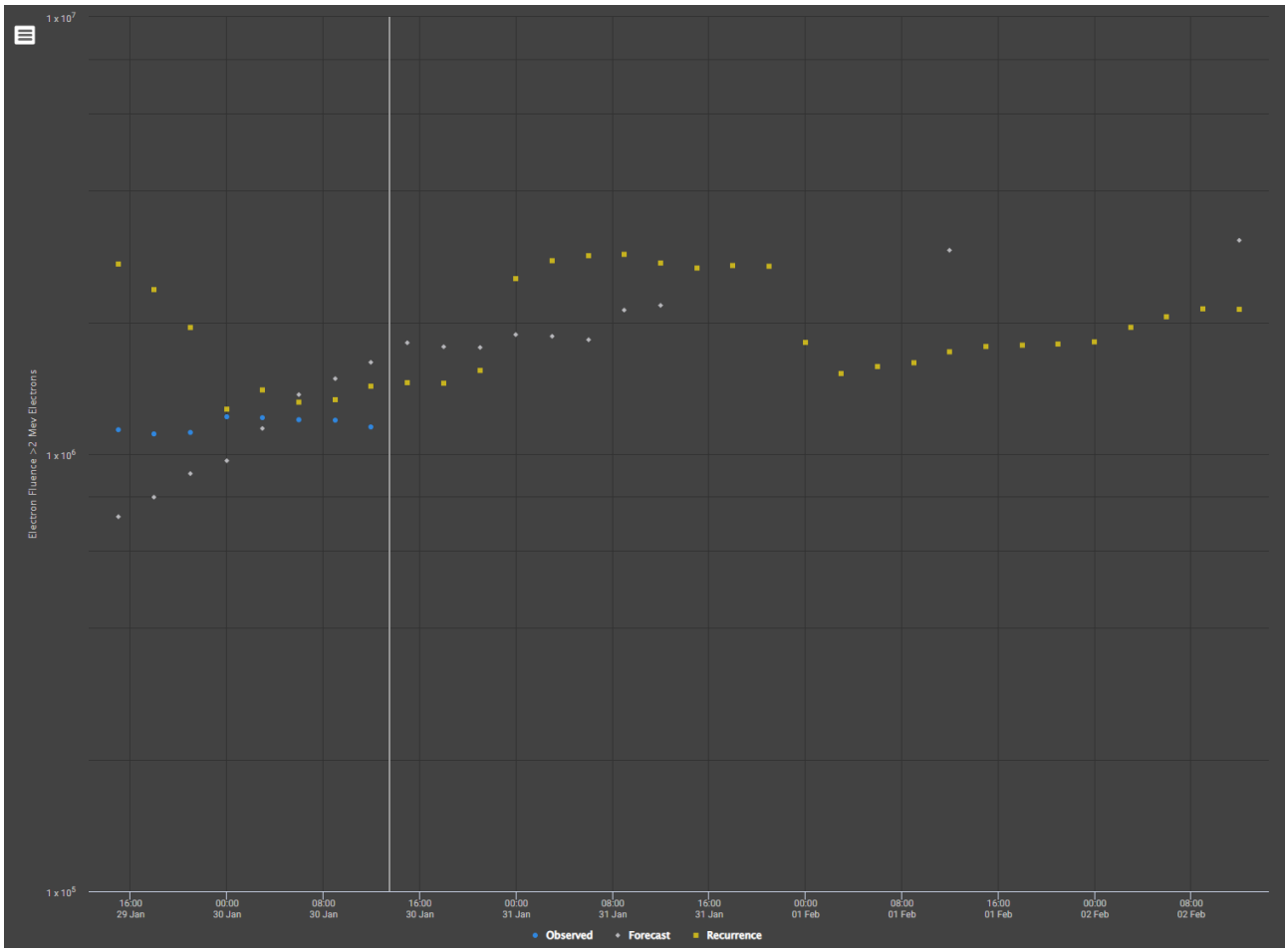
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has spent the whole of the past 27-day rotation below High levels, with an absence of significant drivers to alter this state given the expected lack of potent coronal hole fast winds. Persistence suggesting significant electron flux is unlikely following the current ongoing solar wind enhancement associated with CH94 and CH95, although the latter is at a high solar latitude for any Earth effects.

MOSWOC REFM's projections and persistence values both imply a continuation of the current quiet state, and this is the preferred forecast, although this risk increasingly slightly through the period.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM



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